

What is claimed is:

1    1.    A tracking servo operating method comprising:  
2                 applying a beam spot on an optical disk on which a track  
3         is formed;  
4                 receiving feedback light from said optical disk by a light  
5         receiving unit, which is equipped with a multi-divided  
6         photodetector comprising a first photo- detecting portion and a  
7         second photo-detecting portion being mounted in a manner so as  
8         to be divided right and left relative to a circumferential  
9         direction of said optical disk, receive feedback light from said  
10        optical disk; and  
11                 controlling an actuator through a driver so that a servo  
12         operation in which said beam spot tracks said track is performed  
13         according to an output from said light receiving unit;  
14                 wherein control is so exerted that a high frequency  
15         differential signal is produced by calculating a difference  
16         between a first high frequency signal obtained by having said  
17         first photo-detecting portion receive first feedback light from  
18         said optical disk and a second high frequency signal obtained by  
19         having said second photo-detecting portion receive second  
20         feedback light from said optical disk and that, after a tracking  
21         error signal has been produced based on, at least, the produced  
22         high frequency differential signal, the produced tracking error  
23         signal is binarized and a tracking error edge signal indicating  
24         an edge of rising and falling of the binarized tracking error  
25         signal is extracted and that said first and second high frequency  
26         signals are binarized and, when the binarized first and second  
27         high frequency signals are at a specified same level, an operation

28 of pulling in a tracking servo is performed in response to said  
29 tracking error edge signal.

1 2. The tracking servo operating method according to Claim 1,  
2 wherein setting is made so that said tracking error signal becomes  
3 0 (zero) when said beam spot is positioned at a center of said  
4 track.

1 3. The tracking servo operating method according to Claim 1,  
2 wherein setting is made so that said tracking error edge signal  
3 is extracted when said beam spot has reached either of a center  
4 of said track or a center of a region between the two tracks  
5 adjacent to each other.

1 4. The tracking servo operating method according to Claim 1,  
2 wherein control is exerted so that, after a band of each of said  
3 first and second high frequency signals has been filtered, the  
4 filtered signals are binarized and, when both the binarized first  
5 and second high frequency signals are at a low level, an operation  
6 of pulling in a tracking servo is performed in response to said  
7 tracking error edge signal.

1 5. The tracking servo operating method according to Claim 1,  
2 wherein each of said first and second photo-detecting portions  
3 each are further divided into a front photo-detecting portion and  
4 a rear photo-detecting portion along the circumference direction  
5 of said track, and wherein said first and second high frequency  
6 signals each are obtained by adding a front output signal from  
7 said front photo-detecting portion and a rear output signal from

8 said rear photo-detecting portion.

1 6. The tracking servo operating method according to Claim 1,  
2 wherein movement of said beam spot by said actuator is  
3 accomplished by movement of an objective lens in a light source.

1 7. The tracking servo operating method according to Claim 1,  
2 wherein said light receiving unit further comprises a first  
3 sub-photodetector mounted in a position being isolated left by  
4 1/2 pitches of said track in a direction of crossing said track  
5 from a center of said multi-divided photodetector and comprising  
6 a first left photo-detecting portion and a first right photo-  
7 detecting portion mounted in a manner so as to be divided right  
8 and left relative to a circumferential direction of said optical  
9 disk and a second sub-photodetector mounted in a position being  
10 isolated right by 1/2 pitches of said track in a direction of  
11 crossing said track from a center of said multi-divided  
12 photodetector and comprising a second left photo-detecting  
13 portion and a second right photo-detecting portion mounted in a  
14 manner so as to be divided right and left relative to the  
15 circumferential direction of said optical disk, and hereby being  
16 so configured as to receive feedback light of a sub-beam from said  
17 optical disk, said sub-beam being obtained by dividing a beam  
18 output from a light source and to obtain a first detecting signal  
19 by adding signals output from said first and second left  
20 photo-detecting portions in said first and second sub-  
21 photodetectors and a second detecting signal by adding signals  
22 output from said first and second right photo-detecting portions  
23 in said first and second sub-photodetectors, and to produce a

24 sub-differential signal by calculating a difference between the  
25 obtained first detecting signal and the obtained second detecting  
26 signal, and then to produce said tracking error signal based on  
27 a difference between the produced sub-differential signal and  
28 said high frequency differential signal.

1 8. The tracking servo operating method according to Claim 1,  
2 wherein each of said first and second photo-detecting portions  
3 each are further divided into a front photo-detecting portion and  
4 a rear photo-detecting portion along the circumference direction  
5 of said track, and wherein said first and second high frequency  
6 signals each are obtained by adding a front output signal from  
7 said front photo-detecting portion and a rear output signal from  
8 said rear photo-detecting portion, and furthermore,

9 wherein said light receiving unit further comprises a first  
10 sub-photodetector mounted in a position being isolated left by  
11 1/2 pitches of said track in a direction of crossing said track  
12 from a center of said multi-divided photodetector and comprising  
13 a first left photo-detecting portion and a first right photo-  
14 detecting portion mounted in a manner so as to be divided right  
15 and left relative to a circumferential direction of said optical  
16 disk and a second sub-photodetector mounted in a position being  
17 isolated right by 1/2 pitches of said track in a direction of  
18 crossing said track from a center of said multi-divided  
19 photodetector and comprising a second left photo-detecting  
20 portion and a second right photo-detecting portion mounted in a  
21 manner so as to be divided right and left relative to the  
22 circumferential direction of said optical disk, and hereby being  
23 so configured as to receive feedback light of a sub-beam from said

24 optical disk, said sub-beam being obtained by dividing a beam  
25 output from a light source and to obtain a first detecting signal  
26 by adding signals output from said first and second left  
27 photo-detecting portions in said first and second sub-  
28 photodetectors and a second detecting signal by adding signals  
29 output from said first and second right photo-detecting portions  
30 in said first and second sub-photodetectors, and to produce a  
31 sub-differential signal by calculating a difference between the  
32 obtained first detecting signal and the obtained second detecting  
33 signal, and then to produce said tracking error signal based on  
34 a difference between the produced sub-differential signal and  
35 said high frequency differential signal.

1 9. A tracking servo apparatus comprising:  
2       a light source to apply a beam spot on an optical disk on  
3 which a track is formed;  
4       a light receiving unit having a multi-divided photodetector  
5 comprising a first photo-detecting portion and a second  
6 photo-detecting portion being mounted in a manner so as to be  
7 divided right and left relative to a circumferential direction  
8 of said optical disk to produce a first high frequency signal by  
9 having said first photo-detecting portion receive first feedback  
10 light from said optical disk and a second high frequency signal  
11 by having said second photo-detecting portion receive second  
12 feedback light from said optical disk and to produce a high  
13 frequency differential signal by calculating a difference between  
14 the produced first high frequency signal and the produced second  
15 high frequency signal and to produce a tracking error signal based  
16 on, at least, the produced high frequency differential signal;

17       a controlling unit to binarize said tracking error signal  
18   fed from said light receiving unit and to extract a tracking error  
19   edge signal indicating an edge of rising and falling of the  
20   binarized tracking error signal and, after having filtered a band  
21   of each of said first and second high frequency signals fed from  
22   said light receiving unit, to binarize the filtered signals and  
23   to produce, when the binarized first and second high frequency  
24   signals are at a specified same level, a control signal to start  
25   a servo operation in response to said tracking error edge signal;

26       a driver to produce a driving signal according to said  
27   control signal; and

28       an actuator to move said beam spot according to said driving  
29   signal fed from said driver,

30       wherein control is exerted so that an operation of pulling  
31   in a tracking servo is performed in response to said tracking error  
32   edge signal.

1   10.   The tracking servo operating method according to Claim 9,  
2   wherein setting is made so that said tracking error signal becomes  
3   0 (zero) when said beam spot is positioned at a center of said  
4   track.

1   11.   The tracking servo operating method according to Claim 9,  
2   wherein setting is made so that said tracking error edge signal  
3   is extracted when said beam spot has reached either of a center  
4   of said track or a center of a region between the two tracks  
5   adjacent to each other.

1   12.   The tracking servo apparatus according to Claim 9, wherein

2 control is exerted so that, after a band of each of said first  
3 and second high frequency signals has been filtered, the filtered  
4 signals are binarized and, when both the binarized first and  
5 second high frequency signals are at a low level, an operation  
6 of pulling in a tracking servo is performed in response to said  
7 tracking error edge signal.

1 13. The tracking servo operating apparatus according to Claim  
2 9, wherein each of said first and second photo-detecting portions  
3 each are further divided into a front photo-detecting portion and  
4 a rear photo-detecting portion along the circumference direction  
5 of said track, and wherein said first and second high frequency  
6 signals each are obtained by adding a front output signal from  
7 said front photo-detecting portion and a rear output signal from  
8 said rear photo-detecting portion.

1 14. The tracking servo apparatus according to Claim 9, wherein  
2 movement of said beam spot by said actuator is accomplished by  
3 movement of an objective lens in said light source.

1 15. The tracking servo operating method according to Claim 9,  
2 wherein said light receiving unit further comprises a first  
3 sub-photodetector mounted in a position being isolated left by  
4 1/2 pitches of said track in a direction of crossing said track  
5 from a center of said multi-divided photodetector and comprising  
6 a first left photo-detecting portion and a first right photo-  
7 detecting portion mounted in a manner so as to be divided right  
8 and left relative to a circumferential direction of said optical  
9 disk and a second sub-photodetector mounted in a position being

10 isolated right by 1/2 pitches of said track in a direction of  
11 crossing said track from a center of said multi-divided  
12 photodetector and comprising a second left photo-detecting  
13 portion and a second right photo-detecting portion mounted in a  
14 manner so as to be divided right and left relative to the  
15 circumferential direction of said optical disk, and hereby being  
16 so configured as to receive feedback light of a sub-beam from said  
17 optical disk, said sub-beam being obtained by dividing a beam  
18 output from a light source and to obtain a first detecting signal  
19 by adding signals output from said first and second left  
20 photo-detecting portions in said first and second sub-  
21 photodetectors and a second detecting signal by adding signals  
22 output from said first and second right photo-detecting portions  
23 in said first and second sub-photodetectors, and to produce a  
24 sub-differential signal by calculating a difference between the  
25 obtained first detecting signal and the obtained second detecting  
26 signal, and then to produce said tracking error signal based on  
27 a difference between the produced sub-differential signal and  
28 said high frequency differential signal.

1 16. The tracking servo operating method according to Claim 9,  
2 wherein each of said first and second photo-detecting portions  
3 each are further divided into a front photo-detecting portion and  
4 a rear photo-detecting portion along the circumference direction  
5 of said track, and wherein said first and second high frequency  
6 signals each are obtained by adding a front output signal from  
7 said front photo-detecting portion and a rear output signal from  
8 said rear photo-detecting portion, and furthermore,  
9 wherein said light receiving unit further comprises a first

10 sub-photodetector mounted in a position being isolated left by  
11 1/2 pitches of said track in a direction of crossing said track  
12 from a center of said multi-divided photodetector and comprising  
13 a first left photo-detecting portion and a first right photo-  
14 detecting portion mounted in a manner so as to be divided right  
15 and left relative to a circumferential direction of said optical  
16 disk and a second sub-photodetector mounted in a position being  
17 isolated right by 1/2 pitches of said track in a direction of  
18 crossing said track from a center of said multi-divided  
19 photodetector and comprising a second left photo-detecting  
20 portion and a second right photo-detecting portion mounted in a  
21 manner so as to be divided right and left relative to the  
22 circumferential direction of said optical disk, and hereby being  
23 so configured as to receive feedback light of a sub-beam from said  
24 optical disk, said sub-beam being obtained by dividing a beam  
25 output from a light source and to obtain a first detecting signal  
26 by adding signals output from said first and second left  
27 photo-detecting portions in said first and second sub-  
28 photodetectors and a second detecting signal by adding signals  
29 output from said first and second right photo-detecting portions  
30 in said first and second sub-photodetectors, and to produce a  
31 sub-differential signal by calculating a difference between the  
32 obtained first detecting signal and the obtained second detecting  
33 signal, and then to produce said tracking error signal based on  
34 a difference between the produced sub-differential signal and  
35 said high frequency differential signal.

1 17. A tracking servo apparatus comprising:  
2 a light source to apply a beam spot on an optical disk on

3 which a track is formed;

4       a light receiving means having a multi-divided  
5 photodetector comprising a first photo-detecting portion and a  
6 second photo-detecting portion being mounted in a manner so as  
7 to be divided right and left relative to a circumferential  
8 direction of said optical disk to produce a first high frequency  
9 signal by having said first photo-detecting portion receive first  
10 feedback light from said optical disk and a second high frequency  
11 signal by having said second photo-detecting portion receive  
12 second feedback light from said optical disk and to produce a high  
13 frequency differential signal by calculating a difference between  
14 the produced first high frequency signal and the produced second  
15 high frequency signal and to produce a tracking error signal based  
16 on, at least, the produced high frequency differential signal;

17       a controlling means to binarize said tracking error signal  
18 fed from said light receiving means and to extract a tracking error  
19 edge signal indicating an edge of rising and falling of the  
20 binarized tracking error signal and, after having filtered a band  
21 of each of said first and second high frequency signals fed from  
22 said light receiving means, to binarize the filtered signals and  
23 to produce, when the binarized first and second high frequency  
24 signals are at a specified same level, a control signal to start  
25 a servo operation in response to said tracking error edge signal;

26       a driver to produce a driving signal according to said  
27 control signal; and

28       an actuator to move said beam spot according to said driving  
29 signal fed from said driver,

30       whereby control is exerted so that an operation of pulling  
31 in a tracking servo is performed in response to said tracking error

32 edge signal.

1 18. An optical disk device provided with a tracking servo  
2 apparatus comprising:

3 a light source to apply a beam spot on an optical disk on  
4 which a track is formed;

5 a light receiving unit having a multi-divided photodetector  
6 comprising a first photo-detecting portion and a second  
7 photo-detecting portion being mounted in a manner so as to be  
8 divided right and left relative to a circumferential direction  
9 of said optical disk to produce a first high frequency signal by  
10 having said first photo-detecting portion receive first feedback  
11 light from said optical disk and a second high frequency signal  
12 by having said second photo-detecting portion receive second  
13 feedback light from said optical disk and to produce a high  
14 frequency differential signal by calculating a difference between  
15 the produced first high frequency signal and the produced second  
16 high frequency signal and to produce a tracking error signal based  
17 on, at least, the produced high frequency differential signal;

18 a controlling unit to binarize said tracking error signal  
19 fed from said light receiving unit and to extract a tracking error  
20 edge signal indicating an edge of rising and falling of the  
21 binarized tracking error signal and, after having filtered a band  
22 of each of said first and second high frequency signals fed from  
23 said light receiving unit, to binarize the filtered signals and  
24 to produce, when the binarized first and second high frequency  
25 signals are at a specified same level, a control signal to start  
26 a servo operation in response to said tracking error edge signal;  
27 a driver to produce a driving signal according to said

28 control signal; and  
29           an actuator to move said beam spot according to said driving  
30 signal fed from said driver,  
31           whereby control is exerted so that an operation of pulling  
32 in a tracking servo is performed in response to said tracking error  
33 edge signal.